We Claim:

1. An optical carrier notch filter comprising:

an optical coupler including at least a first, a second and a third port, the first port being configured to receive an output that includes an optical carrier and interleaved optical single sideband signals;

an optical bandpass filter coupled to a port of the optical coupler, the optical bandpass filter separating the output into a transmitted signal that contains the optical carrier and a reflected signal that includes the interleaved optical single sideband signals that are reflected from the optical bandpass filter to the third port of the optical coupler.

2. The filter of claim 1, further comprising:

an external modulator coupled to the optical bandpass filter and the coupler setup in claim 1 to receive the optical carrier, the external modulator modulating the optical carrier to create a modulated optical carrier.

3. The filter of claim 2, wherein a baseband signal is applied to the external modulator to modulate the optical carrier and create the modulated optical carrier.

4. The filter of claim 1, wherein the optical single sideband signals have unequal channel spacings.

5. The filter of claim 1, further comprising:

a coupler used to combine the modulated optical carrier with the interleaved optical single sideband signals.

6. The filter of claim 1, wherein the optical bandpass filter is centered at the same wavelength as the optical carrier.

7. The filter of claim 1, wherein the optical coupler is a circulator.

8. An optical carrier notch filter comprising:

an optical coupler including at least a first, a second and a third port, the first port being configured to receive an output that includes an optical carrier and interleaved optical single sideband signals;

an optical narrowband reject filter coupled to a port of the optical coupler, the optical narrowband reject filter separating the output into a reflected signal that contains the optical carrier and a transmitted signal that includes the interleaved optical single sideband signals that are transmitted through the optical narrowband reject filter.

9. An optical carrier notch filter, comprising:

a multiple port circulator including at least a first, a second and a third port; and

an optical bandpass filter coupled to the second port of the multiple port circulator, the optical bandpass filter separating an output received from the circulator into a transmitted signal that contains an optical carrier and a reflected signal that includes interleaved optical single sideband signals and is reflected from the optical bandpass filter to the third port of the circulator.

10. The filter of claim 9, further comprising:

a modulator coupled to the optical bandpass filter and the coupler setup in claim 8 to receive the optical carrier, a baseband signal is applied to the electrodes of the modulator modulating the carrier to form a modulated optical carrier.

11. The filter of claim 9, further comprising:

a coupler coupled used to combine the modulated optical carrier with the interleaved sideband signals.

12. The filter of claim 9, wherein the interleaved single sideband modulator includes a source that produces first and second sidebands with frequencies that are offset from their harmonics and/or the other sideband's residual image.

13. The filter of claim 12, wherein the offset frequencies are different for the first and second sidebands.

14. An optical carrier notch filter, comprising:

a multiple port circulator including at least a first, a second and a third port; and

an optical narrowband reject filter coupled to a second port of the multiple port circulator, the optical narrowband reject filter separating an output received from the circulator into a reflected signal that contains an optical carrier and a transmitted signal that includes interleaved optical single sideband signals and is transmitted through the optical narrowband rejectba filter.

15. An interleaved optical single sideband communications system comprising:

a Mach-Zehnder modulator, constructed and arranged to accept an incoming optical carrier and including:

a splitter which splits the incoming optical signal into a first optical carrier and a second optical carrier;

a first AC phase modulator to apply a first electrical signal carrying a plurality of first channels to modulate the first optical signal;

a second AC phase modulator to apply a second electrical signal carrying a plurality of second channels to modulate the second optical signal, each first channel corresponding to one of the second channels, and each first channel being phase shifted 90° relative to each corresponding second channel;

a first DC phase modulator to modulate the first optical signal;

a second DC phase modulator to modulate the second optical signal, the first and second DC phase modulators constructed and arranged to modulate an optical carrier component of the first optical signal to be phase shifted 90° relative to an optical carrier component of the second optical signal, the optical carrier component of the second optical signal having a frequency substantially equal to the optical carrier component of the first optical signal;

a directional coupler that coupled to the Mach-Zehnder modulator and combines the modulated first and second optical signals to form a combined optical signal having an optical carrier component, such that alternate channels of the combined optical signal are substantially cancelled; and

wherein the Mach-Zehnder modulator creating a first single side band on a side of the optical carrier frequency, a first residual image on the opposite side of the optical carrier frequency, a second side band on a side of the optical carrier frequency, and a second residual image on the opposite side of the optical carrier frequency.

16. The system of claim 15, wherein a frequency of the first side band is offset from the second residual image, and a frequency of the second side band is offset from the first residual image. Any other new sidebands generated from other optical carriers are also offset from these residual images.

17. The system of claim 15, further comprising:

an optical carrier notch filter coupled to the Mach-Zehnder modulator.

18. The system of claim 17, wherein the optical carrier notch filter comprises:

an optical coupler including at least a first, a second and a third port, the first port being configured to receive an output that includes an optical carrier and interleaved optical single sideband signals;

an optical bandpass filter coupled to a second port of the optical coupler, the optical bandpass filter separating the output into a transmitted signal that contains the optical carrier and a reflected signal that includes the interleaved optical single sideband signals that are reflected from the optical bandpass filter to the third port of the optical coupler.

19. The system of claim 17, wherein the optical carrier notch filter comprises:

an optical coupler including at least a first, a second and a third port, the first port being configured to receive an output that includes an optical carrier and interleaved optical single sideband signals;

an optical narrowband reject filter coupled to a second port of the optical coupler, the optical narrowband reject filter separating the output into a reflected signal that contains the optical carrier and a transmitted signal that includes the interleaved optical single sideband signals that are transmitted through the optical narrowband reject filter.

20. The system of claim 18, further comprising:

an external modulator coupled to the optical bandpass filter, the external modulator modulating the optical carrier to create a modulated optical carrier.

21. An interleaved optical single sideband communications system comprising:

a Mach-Zehnder modulator, constructed and arranged to accept an incoming optical carrier, the Mach-Zehnder modulator comprising:

a splitter which splits the incoming optical signal into a first optical carrier and a second optical carrier;

a first AC phase modulator to apply a first electrical signal carrying a plurality of first channels to modulate the first optical signal;

a second AC phase modulator to apply a second electrical signal carrying a plurality of second channels to modulate the second optical signal, each first channel corresponding to one of the second channels, and each first channel being phase shifted 90° relative to each corresponding second channel;

a first DC phase modulator to modulate the first optical signal;

a second DC phase modulator to modulate the second optical signal, the first and second DC phase modulators constructed and arranged to modulate an optical carrier component of the first optical signal to be phase shifted 90° relative to an optical carrier component of the second optical signal, the optical carrier component of the second optical signal having a frequency substantially equal to the optical carrier component of the first optical signal;

a combiner which combines the modulated first and second optical signals to form a combined optical signal having an optical carrier component, such that alternate channels of the combined optical signal are substantially cancelled; and

a notch filter coupled to the Mach-Zehnder modulator, the notch filter including, an optical coupler including at least a first, a second and a third port, the first port being configured to receive an output that includes an optical carrier and interleaved optical single sideband signals, and an

optical bandpass filter coupled to a second port of the optical coupler, the optical bandpass filter separating the output into a transmitted signal that contains the optical carrier and a reflected signal that includes the interleaved optical single sideband signals that are reflected from the optical bandpass filter to the third port of the optical coupler.

22. The system of claim 21, wherein the Mach-Zehnder modulator creates a first single side band on a side of the optical carrier frequency with a first residual image on the opposite side of the optical carrier frequency, a second side band on a side of the optical carrier frequency with a second residual image on the opposite side of the optical carrier frequency; and a frequency of the first side band is offset from the residual image and harmonics of the second sideband, and a frequency of the second side band is offset from the residual image and harmonics of the first sideband.

23. An interleaved optical single sideband communications system comprising:

a Mach-Zehnder modulator, constructed and arranged to accept an incoming optical carrier, the Mach-Zehnder modulator comprising:

a splitter which splits the incoming optical signal into a first optical carrier and a second optical carrier;

a first AC phase modulator to apply a first electrical signal carrying a plurality of first channels to modulate the first optical signal;

a second AC phase modulator to apply a second electrical signal carrying a plurality of second channels to modulate the second optical signal, each first channel corresponding to one of the second channels, and each first channel being phase shifted 90° relative to each corresponding second channel;

a first DC phase modulator to modulate the first optical signal;

a second DC phase modulator to modulate the second optical signal, the first and second DC phase modulators constructed and arranged to modulate an optical carrier component of the first optical signal to be phase shifted 90° relative to an optical carrier component of the second optical signal, the optical carrier component of the second optical signal having a frequency substantially equal to the optical carrier component of the first optical signal;

a combiner which combines the modulated first and second optical signals to form a combined optical signal having an optical carrier component, such that alternate channels of the combined optical signal are substantially cancelled; and

a notch filter coupled to the Mach-Zehnder modulator, the notch filter including, an optical coupler including at least a first, a second and a third port, the first port being configured to receive an output that includes an optical carrier and interleaved optical single sideband signals, and an optical bandpass filter coupled to a second port of the optical coupler, the optical bandpass filter separating the output into a reflected signal that contains the optical carrier and a transmitted signal that includes the interleaved optical single sideband signals that are transmitted through the optical bandpass filter.

24. An interleaved optical single sideband communications system comprising:

a Mach-Zehnder modulator, constructed and arranged to accept an incoming optical carrier, the Mach-Zehnder modulator comprising:

a splitter which splits the incoming optical signal into a first optical carrier and a second optical carrier;

a first AC phase modulator to apply a first electrical signal carrying a plurality of first channels to modulate the first optical signal;

a second AC phase modulator to apply a second electrical signal carrying a plurality of second channels to modulate the second optical signal, each first channel corresponding to one of the second channels, and each first channel being phase shifted 90° relative to each corresponding second channel;

a first DC phase modulator to modulate the first optical signal;

a second DC phase modulator to modulate the second optical signal, the first and second DC phase modulators constructed and arranged to modulate an optical carrier component of the first optical signal to be phase shifted 90° relative to an optical carrier component of the second optical signal, the optical carrier component of the second optical signal having a frequency substantially equal to the optical carrier component of the first optical signal;

a combiner which combines the modulated first and second optical signals to form a combined optical signal having an optical carrier component, such that alternate channels of the combined optical signal are substantially cancelled; and

wherein the Mach-Zehnder modulator creates a first single side band on a side of the optical carrier frequency with a first residual image on a side of the optical carrier frequency, a second side band on a side of the optical carrier frequency with a second residual image on a side of the optical carrier frequency; and a frequency of the first side band is offset from the second residual image, and a frequency of the second side band is offset from the first residual image.

25. An interleaved optical single sideband communications system according to claim 24, further comprising:

an input polarization controller, constructed and arranged to control a polarization of the incoming optical signal;

a polarization maintaining input optical fiber, constructed and arranged to accept the incoming optical signal from the input polarization controller and to provide the incoming optical signal to the modulator.

26. An interleaved optical single sideband communications system according to claim 24, further comprising:

a light emitting device, constructed and arranged to produce the incoming optical carrier and inject the incoming optical carrier into the modulator;

a notch filter, disposed after the modulator, the notch filter filtering a range of wavelengths including a wavelength of the optical carrier component of the combined optical signal;

a dispersion compensation device, disposed after the notch filter.

27. An interleaved optical single sideband communications system according to claim 26, wherein an amplifier is disposed after the fiber dispersion compensation device.

28. An interleaved optical single sideband communications system according to claim 27, wherein the amplifier is a erbium doped fiber amplifier.

29. An interleaved optical single sideband communications system according to claim 26, wherein the dispersion compensation device is a device selected from the group consisting of: a length of dispersion compensating fiber and a chirped fiber Bragg grating.

30. An interleaved optical single sideband communications system according to claim 24, further comprising an optical receiver receiving the combined optical signal, the optical receiver comprising:

an optical filter, constructed and arranged to pass a range of frequencies corresponding to a selected channel of the combined optical signal; and

a baseband optical receiver, receiving the selected channel.

31. An interleaved optical single sideband communications system according to claim 30, wherein the optical filter further comprises a tunable narrowband optical filter, tunable among a plurality of ranges of frequencies corresponding to channels carried in the combined optical signal.

32. An interleaved optical single sideband communications system according to claim 31, wherein the tunable narrowband optical filter further comprises a feedback circuit such that the filter passband can be locked on to a center of a channel to be passed through the filter.

33. An interleaved optical single sideband communications system according to claim 30, wherein the optical filter further comprises a plurality of fixed narrowband optical filters, each corresponding to a range of frequencies corresponding to a single channel carried in the combined optical signal,

and the baseband optical receiver further comprises a plurality of baseband optical receivers each of which is disposed after a corresponding one of the fixed narrowband optical filters to receive a single channel therefrom.

34. An interleaved optical single sideband communications system according to claim 24, further comprising:

a wideband optical receiver; and

a plurality of demodulators, each demodulator constructed and arranged to extract a range of frequencies from the combined optical signal corresponding to a single channel.

35. An interleaved optical single sideband communications system according to claim 24, further comprising:

a plurality of directional couplers disposed in series before the modulator, the directional couplers combining a plurality of channels to produce a combined electrical signal from which the first and second electrical signals are derived.

36. A method of modulating an optical carrier, comprising:

receiving an output that includes an optical carrier and interleaved sideband signals;

separating the interleaved sideband signals from the optical carrier; and

modulating the optical carrier to create a modulated optical carrier.

37. The method of claim 36, further comprising:

combining the interleaved sideband signals with the modulated optical carrier.

38. The method of claim 36, wherein the interleaved sideband signals have frequencies that are offset from the ITU Grid.

39. A method of re-inserting an optical carrier at a remote location in a network, comprising:

receiving an output that includes an interleaved sideband signals with a suppressed optical carrier;

combining an optical carrier with the same wavelength as the suppressed optical carrier and the interleaved sideband signals at a remote network site.

40. A method of re-modulating or suppressing an optical carrier at a remote location in a network, comprising:

receiving an output that includes an optical carrier and interleaved sideband signals;

separating the interleaved sideband signals from the optical carrier at a remote network site; and

modulating the optical carrier to create a modulated optical carrier or notch out the optical carrier.

41. A method of modulating an optical carrier frequency in a Mach Zehnder interferometer modulator that includes a first phase modulator and a second phase modulator, comprising:

splitting a power of the optical carrier frequency into a first portion and a second portion;

introducing the first portion of the carrier signal frequency to the first phase modulator and the second portion of the carrier signal frequency to the second phase modulator;

applying a first signal to the first phase modulator at a first phase and to the second phase modulator at a second phase;

creating a first single side band on a side of the optical carrier frequency, and a first residual image on a side of the optical carrier frequency;

applying a second signal to the first phase modulator at a first phase and to the second phase modulator at a second phase

creating a second side band on a side of the optical carrier frequency, and a second residual image on a side of the optical carrier frequency; and

wherein a frequency of the first side band is offset from the second residual image, and a frequency of the second side band is offset from the first residual image.

42. The method of claim 41, wherein a frequency of the first sideband is higher than the optical carrier frequency and a frequency of the second sideband is lower than the optical carrier frequency.

43. The method of claim 41, wherein a frequency of the first sideband is higher than the optical carrier frequency and a frequency of the second sideband is higher than the optical carrier frequency.

44. The method of claim 41, wherein a frequency of the first sideband is lower than the optical carrier frequency and a frequency of the second sideband is lower than the optical carrier frequency.

45. The method of claim 41, further comprising:

creating multiple single side bands on the first side of the optical carrier frequency with multiple first residual images on the other side of the optical carrier frequency; and

creating multiple single side bands on the second side of the optical carrier frequency with multiple second residual images on the other side of the optical carrier frequency; and

wherein frequencies of the multiple first side bands are offset from the second residual images, and frequency of the multiple second side bands are offset from the first residual images.

46. The method of claim 45, wherein higher frequency sideband signals are offset from harmonics of lower frequency sideband signals.

47. The method of claim 41, wherein the first and second sidebands are offset from spurious signals.

48. The method of claim 42, wherein the spurious signals are selected from harmonics and intermodulations.

49. The method of claim 41, wherein the first side band and the first residual image are on opposite sides of the carrier signal frequency.

50. The method of claim 41, wherein the second side band the second residual image are on opposite sides of the carrier signal frequency.

51. The method of claim 50, wherein the first and second side bands are on opposite sides of the carrier signal frequency.

52. The method of claim 41, wherein the Mach Zehnder interferometer modulator is a single Mach Zehnder interferometer.

53. A method of transmitting a plurality of channels, comprising:

providing a plurality of electrical signals, each electrical signal corresponding to a channel;

producing a first and a second split signal corresponding to each of the plurality of signals, each first split signal being substantially at quadrature with a corresponding second split signal;

providing an optical carrier signal;

multiplexing the optical carrier signal with the split signals to produce a multiplexed optical signal such that alternate channels are substantially cancelled and residual images of upper side band channels do not substantially overlap channels carried on a lower side band.

54. A method according to claim 53, further comprising filtering the multiplexed optical signal to remove the optical carrier signal.

55. A method according to claim 53, wherein the multiplexed optical signal is further combined with at least one additional multiplexed optical signal by dense wavelength division multiplexing.